Editorial and Call for Papers: Announcing the New Section 'Uncertainties'

Uncertainties in Life Cycle Assessment

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Uncertainties in LCAs are cumbersome, easily ignored, and not wanted. Why a new section 'Uncertainties in LCAs'? For several reasons.

First, there are an increasing number of papers dealing with uncertainties in Life Cycle Assessment and sustainability measures to be found in this Journal: 50 papers have uncertainty as a keyword; the SETAC annual meeting in Prague dedicated an interactive poster session to this topic; the upcoming International Environmental Modelling and Software Society Conference to be held in Osnabrueck, Germany (IEMS, 14–17 June 2004) has a section Uncertainty in LCA, to name just a few.

All these efforts aside, there still seems to be a lack of appropriate methods and ideas on how to deal with uncertainty in LCAs, an 'infancy' of existing methods, going along with a potpourri of definitions and understandings. Common understanding, however, has been reached in that LCA results are uncertain, and in that a number of different aspects contribute to this uncertainty, whereas uncertainty in parameters of the LCA model, and uncertainty in model structure, are most frequently mentioned.

In addition, there seems to be reluctance, from a practitioner's standpoint, to consider uncertainty at all. Addressing uncertainty explicitly, and providing uncertainty figures in results, rather seems to complicate an otherwise clear message of a study. Presenting a deterministic figure instead, 'radiating with credibility', often works in practice and may make sense even from a decision theory standpoint.

Why consider uncertainty in LCAs? LCA commonly is understood as being a decision support tool. Backing the reported figures and results with uncertainty information allows assessing the stability of the result, and in some cases, a ranking order may be changed by considering the underlying uncertainty (see also **Fig. 1**). In a decision, information that changes a ranking of alternatives is evidently of high importance, but also information on the stability of the result provided is immensely helpful. This is the main, and rather simple, reason for uncertainty analysis. For this reason, in medical tests, in public surveys, in quality assurance analyses in product development, and in other fields where a decision based on a result of a study has relevance, uncertainty frequently is addressed.

Recently, LCA has gained attention in legislation, e.g. on the national, German level (the German 'VerpackV' – packaging regulation) and on the EU level (e.g. the eco-design requirements for energy using products Directive), and is discussed as a tool for backing political decisions about the environmental performance of products, or for motivating, case specific deviances from general requirements. This puts more emphasis on the uncertainty question in LCAs.

In addition to this main reason, there are a number of others: Decision makers may have different attitudes towards different types of risk or uncertainty, so the information about uncertainty is highly appreciated and a desired, deliverable feature. Providing uncertainty figures very clearly shows the quality of data underlying a result; hence, a competition towards better data quality is enforced by explicitly stating uncertainty.

On the other hand, incorporating uncertainty assessments in LCAs has drawbacks. It means additional effort and could itself entail errors in the analysis, thus doing more harm than good. Considering uncertainty in an LCA means a form of model sophistication. It might not always be possible to include it in an adequate way, or to include it only for parts of the study. **Fig. 2** shows this in a very general form. Errors due to simplification of reality as well as errors due to misconceiving reality in the model contribute to the overall error. The optimum for model sophistication (see the dotted vertical line in Fig. 2) is not always a highly sophisticated model. It seems that this also holds true for the consideration of uncertainties in LCAs.

It is my pleasure, and a high responsibility, to be Subject Editor for Uncertainties in LCA, in The International Journal of Life Cycle Assessment. The topic is, as I have tried to describe above, of a rather abstract nature, difficult to tackle, yet of high interest today and of increasing practical relevance. And there still seems to be a lot to do.

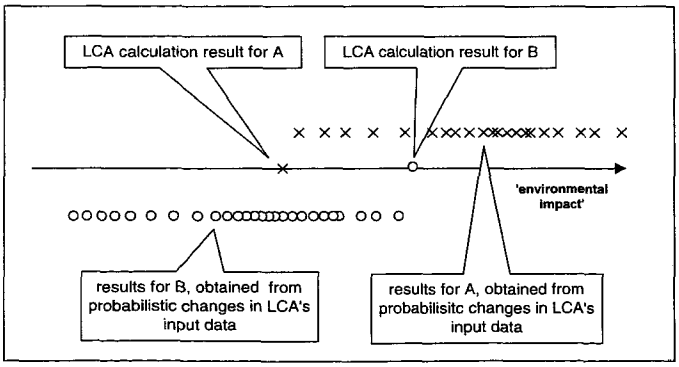

Fig. 1: Is product A preferable from an environmental perspective? A comparison of a deterministic result with results obtained due to uncertain input data

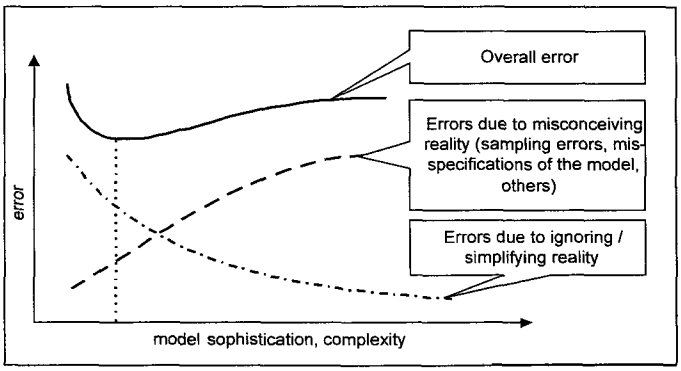

Fig. 2: Too high sophistication in modelling raises the overall error, in a model (based on SRU: Umweltgutachten 1974, Stuttgart 1974, p 208, modified)

This announcement is also a call for papers. The section lives, of course, from submitted papers, and from the engagement and expertise of reviewers who perform reviews for these papers. Evidently, uncertainty should somehow be a topic in the section's papers. Of special interest are papers that recognise existing literature in the field of LCA / uncertainties (not re-inventing already existing definitions or findings), while presenting new insights; these new insights may also be critical remarks on previously published ideas and results. Practical case studies are as important as methodologically oriented papers, and it is most welcomed for the case studies if they indeed describe the flow of a study, with its potential successes and flops – since we need success stories as a guide, while learning most from mistakes.

In one of the forthcoming issues of Int J LCA you will see a publication about my dissertation on uncertainty calculation in LCAs (see below and OnlineFirst, DOI: http://dx.doi.org/10.1065/lca2004.05.158); you may judge for yourself whether it complies with the criteria posed above.

If you consider submitting a paper, send a tentative abstract to my E-mail address. The abstract will be sent to potential reviewers, with the question as to whether they think the paper fits in the section and in the Journal in terms of content and quality. You will receive feedback as soon as possible, and possibly become invited to prepare and submit the full paper. In preparing, please follow the guidelines for authors, available via the Journal's website (http://www.scientific.journals.com/sj/pdf/lca/autorenhinweise.pdf). Having received your manuscript, we then will start the review process. Thus, we will not work as reviewers, but as editors.

I am looking forward to establishing a lively, relevant discussion platform, and to receiving your papers and contributions that help to explore the field of uncertainty in LCAs. **And to make the section indeed a discussion platform, comments on articles, on recent developments and events, and, last but not least, on the concept of the section, are most appreciated.**

Forthcoming in Int J LCA

Uncertainty Calculation in Life Cycle Assessments

A combined model of simulation and approximation

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Goal and Background. Uncertainty is commonly not taken into account in LCA studies, which downgrades their usability for decision support. One often stated reason is a lack of method. The aim of this paper is to develop a method for calculating the uncertainty propagation in LCAs in a fast and reliable manner.

Approach. The method is developed in a model that reflects the calculation of an LCA. For calculating the uncertainty, the model combines approximation formulas and Monte Carlo Simulation. It is based on virtual data that distinguishes true values and random errors or uncertainty, and that hence allows comparing the performance of error propagation formulas and simulation results. The model is developed for a linear chain of processes, but extensions for covering branched and looped product systems are also made and described.

Results. The paper proposes a combined use of approximation formulas and Monte Carlo simulation for calculating uncertainty in LCAs, developed primarily for the sequential approach. During the calculation, a parameter observation controls the performance of the approximation formulas. Concrete parameter values are given in the paper. The combination thus transcends drawbacks of simulation and approximation.

Conclusions and Outlook. The uncertainty question is a true jigsaw for LCAs, and the method presented in this paper may serve as one piece in solving it. It may thus foster a sound use of uncertainty assessment in LCAs. Possible paths for further work include an analysis on how to manage the input uncertainty, including suitable sampling and estimation techniques; they include using the approach for real case studies, implementing it in LCA software for automatically applying the proposed combined uncertainty model and, on the other hand, they include an investigation about how people do decide, and should decide, when their decision relies on explicitly uncertain LCA outcomes.

Published Articles by and with Andreas Ciroth in Int J LCA

A New Approach for a Modular Valuation of LCAs
Ciroth, Andreas; Fleischer, Günter; Gerner, Karin; Kunst, Heiko
8 LCA (5) 273–282 (2003)

Geographical and Technological Differences in Life Cycle Inventories Shown by the Use of Process Models for Waste Incinerators. Part 2
Ciroth, Andreas; Hagelüken, Marcel; Sonnemann, Guido; Castells, Francesc; Fleischer, Günter
7 LCA (6) 363–368 (2002)

Part 1
Ciroth, Andreas; Hagelüken, Marcel; Sonnemann, Guido; Castells, Francesc; Fleischer, Günter
7 LCA (5) 295–300 (2002)

Error Calculation in Life Cycle Assessments (New LCA Theses)
Ciroth, Andreas
7 LCA (5) 310 (2002)

Framework for Modelling Data Uncertainty in Life Cycle Inventories
Huijbregts, Mark A. J.; Norris, Gregory A.; Bretz, Rolf; Ciroth, Andreas; Maurice, Benoit; Bahr, Bo von; Weidema, Bo Pedersen; Beaufort, Angeline
6 LCA (3) 127–132 (2001)